we find an excess of cloud and rain on the equatorial sides of the respective localities where droughts occur.

The Annual Report for 1901 of the Meteorological Commission of Cape Colony shows that in general, over South Africa, the rainfall of 1901 was normal or above, the excess being decidedly large in September and October. Did this excess continue over into the spring of 1902 when the watershed of the Nile had a deficiency? The deficits of 1901 and 1902 in England and Russia were accompanied by excess in parts of the Mediterranean basin.

It may be anticipated that, in general, the areas of excess of rainfall that accompany and really result from the conditions that cause a given area of deficiency will develop at irregular times and places depending on favorable local circumstances, although, in general, subsequent to and on the equatorial sides of the droughty regions.

Thus an unusual movement of ice northward into the south Indian Ocean, due to an unusual southerly component of the wind in that region brings excess of rain to South Africa. But this unusual southerly component over the Indian Ocean, or this outflow from the Antarctic, must be accompanied by either a corresponding northerly component in some higher stratum above this region, or an unusual flow in the lowest stratum from the equator over some other region, possibly on the opposite side of the Antarctic Circle, and this latter would bring about an unusual rain and snow on that side of the antarctic region. As there is a large part of the ocean from which we rarely receive any meteorological information, it is not surprising that we are not yet able to elucidate all the intricacies of the geographic distribution of the areas of excess and deficit of precipitation. Already the Australian drought has been generally succeeded by bountiful rains in many districts and droughty conditions are passing away.

THE RAIN MAKER IN AUSTRALIA.

In connection with the droughts in Australia we have received abundant details of the efforts made to force rain from the unwilling clouds.

At a meeting of the Chamber of Commerce of Broken Hill, Thursday, July 2, the mayor submitted the formula given by Mr. A. J. J. Phelps, of Sydney, and his method was indorsed by several. The formula consists in using sulphuric acid and zinc, the hydrogen set free ascends with aqueous vapor "in spiral columns which are hollow when they reach the rain belt in the atmosphere, and the cold air in that region rushes down to the warmer air below."

Any one can try this simple well-known chemical experiment for making hydrogen, but we have every assurance that no rain will result and no cold air will rush down and no rain belt will be found in the atmosphere. This, in fact, was the experience of Mr. Allen and the Australian committee at Stephens Creek, which reported that "the experiments were not successful, owing to there being rather too much wind to allow the column of gas to ascend perpendicularly."

The failure of Mr. Allen was complete; the excuse was quite unphilosophical and unnecessary.

Previous to Mr. Allen's *fiasco*, a much more imposing attempt had been made by Dr. C. DeLacy McCarthy, who is said to be "a graduate of Trinity College, Dublin, and who spoke with the utmost confidence on the question of the production of rain, saying: 'I will start to work on Wednesday, and you will have rain by Saturday.'"

The Government of South Australia, the Chamber of Commerce, and the water companies of Broken Hill had united in bearing the expense of a special train to bring Dr. McCarthy and five assistants and apparatus from Petersburg. He did not wish the details of his method known except that in general—

He forces chemical fumes into the air for a great distance which create a vacuum in the fourth, fifth, and sixth strata of air. The center of a heat storm is thus formed and the cold air descends, resulting in a heavy tropical rain. The secret of the chemicals was given him by a man in America. He had improved on the system with the aid of a clever Japanese chemist. He changes his methods to suit varying conditions. It may require thirty-two hours of continous work to achieve success. He produced rain in twenty-two hours in Victoria.

Dr. McCarthy delayed three days before beginning; meantime the sky clouded over and predictions were received from Mr. Barrachi, Director of the Meteorological Office, at Melbourne, forecasting rain within three days. McCarthy's experiments began on Wednesday, a furious dust storm prevailed with northwest winds; although the wind and dust were distressing, he announced that "the vacuum is working still far up." But the wind veered to the south and all chance of the predicted rain from the west seemed to disappear. Eventually, "on July 3, Dr. McCarthy suspended operations, saying that conditions were all against him." He expected to resume when favorable predictions should be published by the Meteorological Office.

A few days before this Mr. Rutter, with several local chemists, "Had sent up a column of hydrogen which was followed by clouds and light rain, and they felt certain that a heavy downpour would have resulted had they continued their efforts." Probably, they realized that the clouds and light rain really had nothing to do with their hydrogen gas.

In their extremity the Broken Hill people naturally clutched at the flimsiest straws, "listening even to Mr. F. J. Mars, engineer of the local electric light works, who urged that huge kites should be sent up carrying dynamite to be fired by electricity."

We have given much space to this interesting episode in the great Australian drought, as we hope it may prove to be the last occasion on which the rainmakers will attempt to delude the suffering people with their chemicals, their upper vacuum, their dynamite, and their false theories.

The time has not yet come when man may plow the atmosphere for rain as he plows the soil for crops. If mines must be worked and towns built in arid regions, let the promoters of these schemes be required to build aqueducts and bore wells sufficient in advance to supply the needed water, not waiting until droughts come and the people die. Every place on this globe has its rainy years and its dry years. Areas of cold and heat, wind and calm, rain and drought appear and move and disappear in irregular succession. We must prepare for them and provide against disaster. We can not control the weather, but we may control ourselves.

METEOROLOGY IN THE UNIVERSITIES.

We are pleased to learn that the higher problems of meteorology are treated in the course on "Mathematical Physics" at Cornell University. The last catalogue at page 147 has the following item:

Advanced course open to juniors, seniors, and graduates. No. 45, Mathematical theory of fluid motion, including the mechanics of the atmosphere and vortex motion. Assistant Professor James McMahon.

The Department of Geology and Geography at Harvard University offers the following courses in meteorology and climatology during the coming year.

Geology B, ²*hf.*—Meteorology (elementary course): Lectures, written exercises, observations, and laboratory work. Half-course (second half year): Laboratory work (two hours a week). Assistant Professor R. DeC. Ward.

The lectures present the subject under the following headings: The earth's atmosphere: its composition, temperature, pressure, and general circulation. The moisture of the atmosphere: dew, frost, clouds, rainfall. Storms: cyclones, thunderstorms, tornadoes. Weather. Climate.

The laboratory work consists chiefly in the construction and study of weather maps; practice in the use of ordinary meteorological instruments; individual record of observations; weather forecasting, etc.

Geology 1, ¹*hf.*—Meteorology (second course): Lectures, observations, and reports. Half course (first half year). Assistant Professor Ward.

This course is intended to enable students to make a more thorough study of various important atmospheric phenomena than is possible in the elementary course in meteorology (Geology B). The subjects discussed are as follows: Dew: theories; measurements. Frost: conditions of formation; prediction; protection. Fog: valley, lowland, and city fogs; relation to health; utilization of fog; ocean fog and its relation to navigation. Haze. Clouds: methods of formation; classification; methods and results of cloud measurements; photography; clouds as weather prognostics. Tropical cyclones: development of the law of storms; directions for handling ships in tropical cyclones; the use of oil at sea; cyclones of West Indies, eastern seas, Indian Ocean, etc.; theory of tropical cyclones.

The laboratory work consists in the examination of charts, photographs, diagrams, etc., and in the study of text-books, reports, and articles bearing upon these illustrations. Each student will also make a series of observations on dew, frost, and clouds.

Geology 2, ²hf.—Climatology of the United States: Lectures, library work, and reports. Half course (second half year) Assistant Professor Ward.

In course 2 are considered: The controls of the climates of the United States. The annual, seasonal, and monthly distribution of temperature, pressure, winds, rainfall, cloudiness, and humidity. The probability of rainy days. The climates of special areas, as, e. g., the Plains, the Pacific coast, New England, Colorado, etc. The relations of the climates of the United States to health, habitability, occupations, and soil products. Irrigation: its present status, possible future, and dependence upon the annual rainfall or snowfall.

Geology 3, ²hf.—Climatology of the Eastern Hemisphere: Lectures, library work, and reports. Half course (second half year). Assistant Professor Ward. (Omitted in 1903-4; to be given in 1904-1905.)

Geology 19, ¹hf.—General climatology: Lectures, library work, and a thesis. Half course (first half year). Assistant Professor Ward.

Course 19 is open to those only who have taken Course B, and to students in the Graduate School having equivalent preparation. It is recommended to those who intend to study medicine.

This course is designed to give a general knowledge of climatology in its broader aspects. The lectures present the subject according to the following heads: The astronomical relations of the earth and sun, the changes of the seasons, and the climatic zones and their subdivisions. Climatic factors. Controls of climate. Relations of climate and man, including the climatic control of habitability, occupation, migrations, government, etc. Physiological effects of different climates. Medical Climatology. Acclimatization. Geological, historical, and periodic changes of climate. The text-book is the English translation of Vol. I of Hann's Climatology.

The library and written work involves the special investigation by each student of some subject in connection with the course, and the preparation of a thesis.

Geology 26.—Climatology (advanced course): Conferences, reports, and theses. Assistant Professor Ward.

This course, which may be taken as a whole course or as a half course, provides more advanced work in the subjects of Courses B, 2, 3, and 19, and is open only to those who have passed in these courses. It is intended that the work done in Geology 26 should lead to results worthy of publication.

THE MOVEMENTS OF THE AIR WITHIN AREAS OF HIGH AND LOW PRESSURE.

The Deutsche Seewarte at Hamburg has published in its Archiv. Vol. XXII, the "Inaugural dissertation" of Dr. P. Polis, on the movements of the air within barometric maxima and minima, considered as a contribution to the theory of the cyclone and anticyclone. Doctor Polis's method of study consists essentially in following up certain trains of thought suggested by mathematical and other students and comparing the resulting suggestions with the actual records of wind and cloud movement at six well selected stations in Europe during each month of the year. The six stations are: Hoehenschwand, Carlsruhe, Breslau, Schneekoppe, or Riesenkoppe, Aix-la-Chapelle, or Aachen, Furnes, or Furness, on the coast of Belgium a few meters above sea level. He also studied the mean annual results for fourteen stations including the preceding six. Our general knowledge of the relation between the winds and the isobars had been expressed in fourteen short theorems by Van Bebber in his Lehrbuch, and these are revised by Doctor Polis, who expresses his own results as follows:

1. For different directions of the gradient (at sea level), the magnitude of the angular deviation of the wind from the gradient, or the angle alpha (α), is a function of the friction, but the velocity of the wind, as well as the orographic conditions, exert a modifying influence. [The gradient is normal to the isobar.—ED.]

2. In Europe, east winds or land winds have a small angular deviation, but west winds or sea winds have a large one. With gradients toward the southeast, the west and east winds even indicate inversions in the angle of deviation opposite to that required by the law of Buys-Ballot.

3. At altitudes of 1000 meters and above there is an outflow of air at the front, but an inflow of air at the rear of the barometric minima, considering the isobars as at sea level.

4. In the cyclone the angle of deviation is greater than in the anticyclone and generally increases with increasing depth of the cyclone.

5. The average annual deviation is generally greater in the warm season of the year than in the cold season.

6. The angle of deviation increases, both with approach to the coast and with increasing height above the ground.

7. In cyclonic motions of the air the swifter winds go with the greater angles of deviation; on the other hand, in anticyclonic motions the swifter winds accompany the smaller angles of deviation.

8. In cyclones over the land the most frequent value of the angle of deviation nearly coincides with the mean value, whereas at the coast and high stations the most frequent value considerably exceeds the mean of all.

9. The frequency of angles of deviation equal to or greater than 90° quickly increases with decreasing distance from the sea as well as with increasing elevation above the earth's surface.

10. At altitudes of 1600 meters the frequency curve for the angle of deviation shows two decided maxima; in one case when (α) is less than 90° in advance of cyclones, there is an inflowing current; in the second case for which (α) is greater than 90°, there is an outflowing current of air. Similar conditions prevail, even if not so distinctly accentuated in the rear of the anticyclone.

11. In land cyclones the greatest force of the winds occurs in the west quadrant; in cyclones on the coast and in the neighborhood of the coast, it occurs in the south quadrant; but in anticyclones in front.

12. The wind force is greater in winter than in summer, and greater in cyclones than in anticyclones.

13. The force of the wind decreases with increasing height of barometer and, inversely, it increases up to a certain point with decreasing height of barometer.

14. The great cyclones of the middle latitudes can not be explained by the distribution of pressure on the earth's surface alone.

15. The causes of the movement of cyclones are for the most part of a mechanical nature. The direction of their movement coincides with that of the air current having the greatest angle of deviation; the latter, as a rule, lies at an altitude of over 1000 meters.

16. On this account the direction of motion of cyclones is in general easterly for Europe, because most frequently the whole air column over an area of low pressure reaches up to a height of more than 1000 meters. Here and up to the region of the cirrus clouds the greatest outflow takes place in the east quadrant and the greatest inflow in the west quadrant.

17. If at an average altitude on the west side the angle (α) is greater than 90° (whence the wind in the west quadrant must blow out from the depression), then the movement of the depression takes place in a westerly direction.

18. In Europe the polar tendency of the cyclones in the warm season and their equatorial tendency in the cold season correspond to the greatest outflow of air on the Schneekoppe that corresponds to the direction of the line of motion of the cyclone.

19. The mean distance of the cyclonic centers from the sta-